

Oxygen buffer assemblages controlling solid solution compositions of clinopyroxene-garnet and tremolite-epidote pairs

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Oxygen buffer assemblages of the Ca-Mg-Fe-Al-Si-O-H system controlling solid solution compositions of equilibrated clinopyroxene-garnet and tremolite-epidote pairs under quartz saturated conditions have been investigated numerically and analytically. The pairs with calcite and quartz assemblages have been frequently used for estimating oxygen fugacities during skarnization (e. g., Omori and Mariko, 1999). However, the assemblages may rarely occur at high temperature conditions in which fugacities of CO₂ and total concentrations of aqueous carbonic species, mainly CO₂ and/or CH₄, are probably unrealistically high. Therefore, we examined buffer assemblages other than carbonates.

Since the assemblage may change with the solid solution compositions of the pair, interactions between fluids of initially high and low oxygen fugacities and rock columns composed of one of the pairs and quartz have been numerically simulated to investigate preliminarily what mineral precipitates, resulting in buffering the oxygen fugacity. Then, analytical solutions for the fugacities buffered by the assemblages were obtained. An advantage of the present approach is that one may easily find the stable buffer assemblage, that is, no mineral over saturates under the buffered condition, if the reactive minerals concerned in the simulations are adequate.

A simulated column is initially filled with quartz and one of the pair with sufficient amounts so that the solid solution compositions do not change during fluid mineral interactions. Then, the interactions between the minerals and the fluids with initially high and low oxygen fugacities were simulated to search the oxygen buffer assemblages. Reactive minerals other than the above ones concerned in the analyses are anorthite, wairakite, laumontite, prehnite, zoisite, margarite, wollastonite, clinocllore, chlorite hematite and magnetite.

Coupled buffer assemblages limiting the oxygen fugacities under which the solid solution compositions of the pairs are stable could be identified. The coupled assemblages for the clinopyroxene-garnet pair with quartz at 1 kb and 500C consist with wollastonite buffering the lowest oxygen fugacity and with anorthite, epidote or magnetite for the upper limit. It was simulated that wollastonite precipitates when the fugacity of the system composed of a fluid, the pair and quartz decreases, resulting in buffering the fugacity, while anorthite, epidote or magnetite precipitates when the system fugacity increases. In the latter case, the additional mineral for the assemblage depends on the solid solution compositions of the pair. Although conditions between the limits are buffer free zones where the solid solution compositions are stable, a range in fugacity of the zones is less than about one log unit (in bars). This may imply that naturally occurring solid solution compositions of the pair with quartz were practically controlled by oxygen fugacities even when the additional mineral for the buffer assemblage could not be observed.

The coupled buffer assemblages for the tremolite-epidote pair and quartz at 1 kb and 350C are consisted with chlorite and magnetite for the upper limit of the oxygen fugacity, while with prehnite, clinopyroxene and garnet for the lower limit.

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